STRUCTURAL DECKING SYSTEM

Technical Field

The present invention relates to structural decking systems and to composite slabs that include the systems.

The present invention also relates to a method of manufacturing structural decking systems.

The present invention relates particularly to structural decking systems for constructing composite slabs.

A major, although not the only, end use application of such structural decking systems is in the construction of composite slabs that form floors in buildings (which term includes car parks).

Another, although not the only other, end use application of such structural decking systems is in the construction of composite slabs that form vertical wall panels.

Background Art

(a) Conventional composite slab construction

Structural steel decking can serve a dual function when used in the construction of composite steel/concrete floor slabs and beams. The decking can act as *structural formwork* by supporting building materials and personnel before the concrete hardens. In addition, after reinforcing steel (bars and/or mesh) has been laid, and concrete has been poured on top of the decking, and the concrete has reached sufficient compressive strength,

the decking can act as *main reinforcement* by interacting with the concrete. When the decking acts as main reinforcement it will continue to do so for the remainder of the life of the building.

All of the types of steel decking described in this section interact with the hardened concrete to take advantage of composite action.

The cellular panel described in Australian patent application 12620/70 in the name of H.L. Burn et al is a one-way load-carrying panel that falls outside this description.

(b) Existing steel decking profiles

Conventional structural steel decking is roll-formed from flat steel strip into long panels of uniform cross-section. Decks are principally distinguished by differences in their cross-sectional shape or profile. The profiles used in the world today are very varied, e.g. trapezoidal decks with "open ribs" (see Fig. 1(a)) versus decks with "closed ribs" (see Fig. 1(b)), but they all have one factor in common: the nominal thickness of the sheeting is constant around the profile perimeter.

Also, roll-forming machines are only designed to roll steel sheeting up to a certain maximum thickness, e.g. 1.2-1.6 mm. This significantly restricts the maximum flexural stiffness and ultimate strength of a deck with a set geometry. This in turn can severely impact on the minimum overall depth of the steel decking that can be used to achieve a certain span, which itself can significantly affect the minimum overall depth of the composite slab.

Conventional roll-forming machines are only used

to manufacture one profile of steel decking. The nominal dimensions of the geometric features that define the profile, e.g. the overall depth, cannot be significantly varied.

Therefore, if a greater spanning or load-carrying capability is required and the profile must be changed, then new roll-forming sets must be built.

Therefore, with demand growing in the world today for decking to be used in a variety of applications, major decking manufacturers are beginning to produce a suite of decks from flat steel strip, with each deck requiring different roll-forming sets.

The suite of decks includes some very deep decks (greater than 200 mm) that are used in the construction of composite slabs having a thin coverage (typically, 50 mm) of concrete over the tops of the ribs and therefore exhibit one-way action.

Flat steel strip used to roll-form any given deck is one steel grade. Therefore, the steel in all of the parts of a roll-formed deck (flanges and webs) has the same yield stress.

The coating on flat steel strip can be varied to some degree between the top and bottom surfaces. For example, it can be galvanised on both surfaces but pre-painted on the side that will form the soffit exposed to the air. Alternatively, the steel can be uncoated on both sides, which is done in benign environments to reduce the cost.

Some decking manufacturers modify the decks they produce once the decks have been roll-formed. This is done to improve their functionality or structural performance.

Important aspects of structural performance are flexural stiffness and ultimate strength. Flexural stiffness affects the magnitude of vertical deflections, in particular under the weight of wet concrete, which often control in design. The moment capacity and shear capacity of critical regions affects ultimate strength, which can also control in design.

Two types of modified decks are discussed below.

(i) "Cellular" decks that are made by welding a flat sheet of steel across the entire base of each decking panel (see Fig. 1(c)).

This arrangement creates closed cells for the passage of sensitive building services, in particular electrical cabling for computers, thus giving rise to so-called "electrified floors".

Attaching the flat sheets to the decking panel also increases the load-carrying capacity and flexural stiffness of the original deck, provided the connection between the sheet and the deck is sufficiently strong. Therefore, this functional improvement can also improve the structural performance of the deck when it acts as formwork.

Importantly, for example as is disclosed in Canadian patent 704842 in the name of H.H. Robertson Company, the decking element fixed to the top of the flat base sheet may be incomplete, with the base sheet incorporating side lap joints. This also led the inventors of the patent to adopt the unusual option of welding the W decking without the lap joints upside-down to the underside of the same decking with lap joints, thus forming a closed multi-cell box deck. Similar decks are shown in Canadian patent 692135 in the name of Inland

Steel Products Company.

Japanese patent 11-192613 in the name of NKK Corporation shows a form of cellular deck which includes a series of openings in the webs of the trapezoidal ribs to accommodate transverse reinforcing bars. It is not clear from the patent the way the cellular deck is manufactured. In any case, the trapezoidal rib of the panel is formed as one part and would therefore be of uniform thickness like conventional decking. It could be that these trapezoidal ribs (which could also be referred to as inverted troughs) are individually welded to a flat plate to form an inverted form of the cellular panel described in Burn's Australian patent application 12620/70. The transverse reinforcing bars appear to clip into the holes in the web sides, and most likely act as shear keys in the final composite slab once the concrete has hardened, noting that the concrete would fill the decking ribs and encapsulate the bars. Another arrangement shown in the Japanese patent application appears to comprise transverse reinforcing bars welded to the tops of the trapezoidal ribs, presumably again to promote composite action between the decking and the concrete.

(ii) The structural performance of a closed-rib decking produced in Australia (Stramit's Condeck HP) has recently been improved by screwing a continuous rib to the side of the lap joint when it acts as formwork (see Fig. 1(d)).

This attachment is located on the top face of the decking and is cast in the concrete and can potentially increase or decrease the longitudinal slip resistance of the plain deck, depending upon its design and the strength of its connection to the rib.

However, in accordance with the manufacturer's

recommendations, the attachment is only connected to the steel decking by three small screws placed through the rib sides (one at the end support, one at mid-span, and one at the accessory end within the internal span), and by two small screws or shot-fired pins through the base of the accessory and into the steel beams at the ends of the span being strengthened. Therefore, interaction between the sheeting and the accessory is very limited. The manufacturer discounts any improvement to the flexural stiffness of the steel decking on account of the accessory. The moment capacities of peak moment regions are assumed to increase, but the increases claimed again only reflect a low level of longitudinal shear connection between the decking and the accessory. Another major disadvantage with this invention is that the accessory must be fitted when the sheeting is in its final position in the building. The manufacturer discounts any effect that the accessory might have on the longitudinal slip resistance of the deck, which could be an unsafe conclusion.

The description of the modified decks in items (i) and (ii) above is not to be taken as an admission of the common general knowledge in Australia.

Disclosure of Invention

The present invention is an alternative structural decking system to the above-described systems.

According to the present invention there is provided a main decking panel for a structural decking system that includes a plurality of the main decking panels, with the main decking panel including:

(a) a base component that includes a central pan and lap joints on each side of the pan to enable adjacent main

decking panels to be positioned side by side in overlapping relationship; and

(b) a strengthening component in the form of an inverted channel member secured to the base component, with the channel member including two opposed side walls formed from web components and a top formed from a chord component, and with the web and top chord components being manufactured as separate components and thereafter assembled together to form the channel member.

A significant advantage of the present invention is that the use of separate components that are assembled together makes it possible to optimise the structural requirements of the components to the required performance of the components.

Preferably the central pan includes at least one longitudinal stiffener.

Preferably the web components are secured to the base component at locations between the longitudinal stiffener or stiffeners and the lap joints.

Preferably the web components butt against the longitudinal stiffener or stiffeners and/or the lap joints.

Preferably the lap joints are formed so that a successive decking panel can be positioned in side by side overlapping relationship with another decking panel by pressing the lap joint of the successive decking panel downwardly over the lap joint of the other decking panel.

Preferably the strengthening component is secured to the base component at a plurality of discrete connection locations along the length of the channel

member.

Preferably the strengthening component is secured to the base component at the plurality of discrete connection locations by deformed sections of the components at the locations that interlock the components together.

Preferably the deformed sections are button shaped.

The deformed sections may be formed by holding the components together and pressing the deformed sections, such as buttons, from one side of the components.

Preferably the web components and the top chord components are assembled together by securing the components together at a plurality of discrete connection locations along the lengths of the components.

Preferably the web components and the top chord components are secured together at the plurality of discrete connection locations by deformed sections of the components at the locations that interlock the components together.

Preferably the deformed sections are button shaped.

The deformed sections may be formed by holding the components together and pressing the deformed sections from one side of the components.

Preferably the web components include flanges and the web and top chord components are secured together at the flanges.

Preferably the top chord component includes one or more than one longitudinal stiffener.

Preferably the stiffener or stiffeners extend along the length of the top chord component.

Preferably the top chord component includes down-turned sides.

The longitudinal stiffeners and the down-turned sides of the top chord component are provided to strengthen the decking panel. Specifically the longitudinal stiffeners and down-turned sides stiffen the top chord component to resist buckling due to longitudinal compression loads.

Preferably the web components include corrugations.

Preferably the corrugations are vertical corrugations.

The corrugations are provided to strengthen the decking panel. Specifically the corrugations stiffen the web components to resist vertical and longitudinal shear.

Preferably the web components include openings to allow concrete to flow into the channel member.

The decking panel may include a plurality of parallel strengthening members.

According to the present invention there is also provided a structural decking system formed from a plurality of the above-described main decking panel positioned side by side with the lap joints in overlapping

relationship.

Preferably the structural decking system includes an infill decking panel that is positioned between two main decking panels, with the infill decking panel including lap joints on each side of the pan that are in overlapping relationship with the lap joints of adjacent main decking panels.

According to the present invention there is also provided a composite slab that includes the above described structural decking system and a layer of hardened concrete on the structural decking system.

Best Modes of Carrying Out the Invention

The main features of embodiments of the main decking panel and the structural decking system of the present invention are described below, by way of example, with reference to Figures 2 to 17.

It is noted that the main decking panels are described as "hybrid" decking panels in the Figures.

The structural decking system of the present invention is based on modules in the form of:

(a) main decking panels; and

(b) infill decking panels.

The main and infill decking panels are typically 2.5-9m long.

Figures 6-8 are vertical cross-sections perpendicular to the lengthwise axis of embodiments of the main decking panel that includes:

(a) an elongate base component that includes a central pan 7 and lap joints 9 on each side of the pan to enable adjacent main decking panels to be positioned side by side in overlapping relationship; and

(b) an elongate strengthening component in the form of a single inverted channel member that is secured to the base component, with the channel member including two opposed sides 11 formed from web components and a top 13 formed from a chord component, and with the web and top chord components being manufactured as separate components and thereafter assembled together to form the channel member.

In each of the above-mentioned embodiments the web components are secured to the base component and the top component is secured to the web components at discrete locations along the lengths of the components. In the case of the embodiments shown in Figs. 6-8 the connections are in the form of deformed buttons 17 that interlock the components together. The nature of the connections between the components is discussed further in a later part of the description.

Each embodiment of the infill decking panel shown in the Figures includes a central pan and lap joints on each side of the pan that are formed to allow the infill decking panel to be positioned in side by side overlapping relationship with the lap joints of adjacent main decking panels.

Two specific embodiments of the infill decking panel 5 are shown in Fig. 2(d). The Figures show cross sections perpendicular to the lengthwise axis of the infill decking panels. The lower embodiment of Fig. 2(d) has a flat pan 21 and lap joints 9 the upper embodiment

has a pan 21 with trapezoidal profile.

Figs. 3-5 and 10-11 illustrate a series of different combinations of main and infill decking panels connected together in side by side overlapping relationship to form structural decking systems.

Preferably the main decking and infill decking panels are narrow single units (see Figs 3 and 4), ie units with a single strengthening member in the case of the main decking panels. Typcially, the main decking and infill decking panels are 200-350mm wide. The present invention is not confined to this arrangement and extends to arrangements in which there is more than one strengthening member.. The preference for narrow modules is to keep the weight per unit length down and allow the panels to be used in long lengths and lifted individually and easily handled on site by workers.

Being the main spanning elements, the main decking panels 3 can be used by themselves (see Figs. 3(a), 4(a) and 10).

Alternatively, infill decking panels 5 can be fitted between the main decking panels to improve economy (see Figs 3(b), 4(b) and 11), since they are less costly to manufacture than the main decking panels, and to provide other benefits such as reducing weight, etc.

Using infill panels 5 makes it possible to introduce voids 27 between adjacent main decking panels or to accommodate longitudinal prestressing cables or reinforcing bars placed low in a composite slab.

The main decking panels 3 are preferably placed in position first to support the infill panels 5, which only span in the transverse direction perpendicular to the

main span.

The main decking panels 3 are preferably assembled from purpose-built steel components (see Figs. 2, 9 and 12).

The major dimensions (e.g. thickness, width and height) and the mechanical properties of the steel components can be varied in production to provide main decking panel designs that are more economical than the known decking systems described above and which can satisfy a much wider and more demanding range of design requirements including achieving very long un-propped spans (e.g. up to 8-9 metres) and allowing reinforced-concrete floors of minimum overall depth to be built.

The different durability requirements of each component can also be taken into account and the steel coatings can be varied to improve economy.

The components of the main decking panels 3 and the infill panels 5 can be efficiently packaged and transported to distant assembly sites. This centralises main production, and can save on transportation costs.

The web components of the main decking panels 5 can be purpose-designed to provide high vertical shear capacity, thereby allowing the decking panels to be pre-cambered during manufacture, and to accommodate regularly-spaced, large unreinforced or reinforced openings for multiple purposes including the passage of transverse steel reinforcing bars and prestressing cables.

The web components of the main decking panels 3 may include openings 29 punched along the length of the panel. Typical openings are shown in Figs. 14 and 17. This is particularly desirable in situations when it is

necessary to partially or entirely fill channel members to form a solid concrete slab or to pass transverse reinforcing bars and cables and/or building services. Two-way acting concrete slabs can thus be constructed and the resulting improvements in structural efficiencies compared with one-way acting slabs can be achieved. For this purpose, the lap joints 9 of the main decking panels (and the infill decking panels) should preferably be shallow, e.g. 20-30 mm.

The openings 29 in the web components of the main decking panels can be placed close to end supports and still perform adequately. Typically, the nearer sides of the openings 29 are 2-3 times the height of the web components inboard of the end supports. In addition, typically, the height of the openings 29 is no more than 60% of the height of the web components. In addition, typically, there is at least 15% web material clearance above and below the openings 29. Computer-controlled punching equipment may be used to place the openings 29 as required along the length of the web components.

The web components of the main decking panels 3 may have deep vertical corrugations 33 (see Figs. 7 an 14). Preferably the corrugations 33 have a pitch of 20-50 mm and a crest-to-valley height of 3-6 mm. Preferably the corrugations 22 are stamped in the web components. The corrugations 33 make it possible to achieve a high level of vertical shear capacity with the thinnest possible steel sheeting. For easier forming the grade of steel used in the web can be reduced compared with the other components, which also has economic benefits. For economy, the steel can be left uncoated because it is later cast in concrete. This is also a way of reducing glare from sunlight, which can be a safety problem for workers on site working with metal coated decks. The height and spacing of the openings in the webs can be varied along

the length of the main decking panels, e.g. to accommodate the passage of transverse prestressing cables which normally vary in height above a slab soffit.

The web components of the main decking panels 3 are preferably roll-formed with a camber in their flat plane. This can be achieved by varying the pitch of the vertical corrugations slightly between the top and bottom regions of the web components or by stretching the flanges.

Separately formed top chord component, web components, and base component, with the web components having the above-described camber, can be assembled on a curved bed to produce a permanent upwards camber in the main decking panel (Fig. 17). This allows bending strength rather than flexural stiffness to govern design, which can lead to a significant reduction in the quantity of steel needed to manufacture the main decking panels for any given situation. It also means that a flatter soffit can be produced in the final structure.

To assist with manufacturing, the web components of the main decking panels 3 are preferably assembled at the same angle to the vertical, irrespective of their overall height (see Figs 7 and 8). Preferably the angle is in the range of 60-80°, more preferably 70-80°.

The distance between the web components of the main decking panels 3 at their connections onto the base component is also preferably kept constant. Therefore, the longitudinal stiffeners of the main decking panels vary in width across their tops, becoming narrower as the longitudinal stiffener height increases.

The web components of the main decking panels 3 may have outwardly angled flanges 35 or inwardly angled

flanges 37 or outwardly/inwardly angled flanges. The options are shown for example in Figs. 2-8 and 10-12. The options facilitate connection of the web components to the top chord component and to the base component.

There may be situations in which it is necessary to strengthen the upper flanges 35, 37 of the web components. One such situation is where the main decking system is subject to long wave buckles that can lift the top chord component up to 5-10mm and straighten the upper flanges of the web components. Suitable strengthening options include providing crimped stiffeners in the corners between the flanges and the upstanding web of the web components.

The openings 29 in the web components of the main decking panels (Figs. 14 and 17) can be partially stamped during manufacture so that they can be selectively knocked out on the building site as required.

By way of example, the openings 27 may be knocked out on site over internal walls that run perpendicular to the span of the decking. As a consequence, the decking does not create a void over the walls, which can otherwise be a problem acoustically or for fire rating.

It may also be necessary to locally fill the void with concrete over the support in this manner if the support is a steel beam and shear connectors are going to be fitted close to the steel longitudinal stiffener of the main decking panel, which would otherwise be weakened by rib punch-through.

The top chord component of the main decking panels 3 is preferably purpose-designed to concentrate a large area of cheaper, uncoated and lower-grade steel than base component near the upper-most extremity of the steel

deck. This is a highly efficient way of enhancing the moment capacity and flexural stiffness of the panels, under conditions of either positive or negative bending.

The top chord component of the main decking panels 3 is preferably designed to develop a sufficiently high level of mechanical resistance with the hardened concrete so that it can act as effective longitudinal tensile or compressive reinforcement in the composite slab.

In part the mechanical resistance develops due to the discrete connections between the top chord component and the web components.

The top chord component may also include lengthwise extending stiffeners 39 (Figs. 7, 8, and 10-12) or its sides may be downwardly turned (Figs.6-8 and 10-12) or deformed or punched to improve the stiffness of the top chord component and therefore the mechanical resistance without interfering with the integrity of the connection between the components.

The top chord component of the main decking panels can be designed to be compact, i.e. develop its full potential compressive capacity without failing prematurely by local buckling. This is helped by the component being relatively thick compared with normal steel decking. To be compact it is preferably attached to the web components of the main decking panel at close centres longitudinally along the length of the main decking panels.

Preferably the top chord component of the main decking panels 3 is relatively wide so that it can form a large surface area to walk on during construction and provides a wide support for reinforcing bars laid

transversely on top of the component.

Preferably the top chord component of the main decking panels 3 is relatively thick compared with normal steel decking and therefore is much more robust against accidental damage during handling and on site.

Whilst it may not always be the case, generally the thickness of top chord component will be greater than that of the web components. Typically, the top chord component is up to 3-4 times the thickness of the web chord component.

The ends of the top chord component of the main decking panels 3 may be manufactured with additional mechanical features (e.g. embossments and punched tapered holes) that further enhance the mechanical resistance developed in these regions, thus significantly reducing the length of lapping bars required over support regions in negative bending.

The top chord component of the main decking panels may be manufactured with mechanical features (e.g. embossments 41 - Figs. 6-8 and 12) along the length to improve the mechanical interlock with the hardened concrete.

The base component of the main decking panels 3 can be purpose-designed to concentrate a large area of steel and develop a large longitudinal tensile or compressive force near the lower-most extremity of the steel deck. This is a highly efficient way of enhancing the moment capacity and flexural stiffness of the panels, under conditions of either positive or negative bending.

Preferably the base component of the main decking panels 3 includes longitudinal stiffeners 45

(preferably 20-30 mm high) - see Figs. 6-11.

The stiffeners 45 in the base component also facilitate assembly of the main decking panels 3. Specifically, the sections of the base component between the stiffeners 45 and the lap joints 9 form footprints for the lower flanges 35 of the web components.

In addition, preferably the stiffeners 45 in the base component are formed so that the lower upwardly extending sections of the web components butt against the stiffeners and this arrangement contributes to the mechanical interlock of the components of the main decking panels.

The base component of the main decking panels can be roll-formed from the thinnest possible galvanised high-tensile steel sheeting, e.g. G550, 0.55 mm. The galvanising makes the soffit of the decking durable, which can also be pre-painted for additional corrosion resistance or for appearance and functionality.

Preferably the base component of the main decking panels 3, acting in conjunction with the web components and their connections, is designed to develop a sufficiently high level of mechanical resistance with the hardened concrete so that it can act as highly effective longitudinal tensile or compressive reinforcement in a composite slab.

The base component of the main decking panels can be modified slightly to allow the component to be used as an infill decking panel. Fig. 9 shows such a modified panel that can be used as an infill panel. The panel shown in Fig. 9 includes embossments 61 and is formed with both lap joints 9 being adapted to be pressed over lap joints of adjacent side by side positioned main decking

panels.

The infill decking panels can be purpose-designed to economically cover a gap between adjacent main decking panels.

The lap joints 9 of the main and infill decking panels 3, 5 are preferably designed so that the infill decking panels can be installed from the top once the main decking panels are in their final position in the building (see Figs. 5, 10, and 11). This feature recognises the highly limited longitudinal spanning capability of the infill decking panels compared with the hybrid decking panels.

The infill decking panels are also preferably designed to develop a sufficiently high level of mechanical resistance with the hardened concrete so that they can act as effective longitudinal tensile or compressive reinforcement in the composite slab. In order to do this the lap joints may be specially designed to grip concrete and the panels may be embossed (see Fig. 9) or otherwise formed for this purpose.

The infill decking panels 5 may take on a variety of shapes, e.g. flat (possibly including a slight camber) to give a final flat soffit, or trapezoidal to create a ribbed one-way composite slab.

The infill decking panels may also be fitted with internal voids, such as styrene blocks, to reduce the volume of concrete (Fig 3(b)).

For economy, the panels are preferably roll-formed from the thinnest possible galvanised high-tensile steel sheeting, e.g. G550, 0.55 mm. The galvanising makes the soffit of the decking durable, which can also be pre-

painted for additional corrosion resistance or for appearance and functionality.

The components of the main decking panels 3 can be assembled together without using welding, and this is an advantage because it allows pre-painted and other types of high-quality sheeting coatings to be used on the exposed soffit of the panels that may otherwise be damaged during a welding operation.

Non-welded connection options include glueing, deforming, clinching (without perforating) and conventional mechanical fasteners.

As discussed above, a preferred non-welded connection option shown in the Figures is in the form of "buttons" 17 (Figs. 6-8) pressed from the components at the connection locations. Specifically, the connections are formed by holding the 2 components together at the connection location and applying a die to one side of the components and pressing through the components and deforming the components and pressing a button of the deformed material from the other side of the components. The end result of this process is that the components are interlocked at the connection locations and therefore the connectors can carry longitudinal and transverse shear forces as required for a given design.

The connection together of the components of the main decking panels 3 provides an important contribution to the mechanical resistance developed by these panels in the hardened concrete. Also, the design of the connection between the components, in particular the frequency of the connections along the length of the panels, can be varied as required given the particular load and support conditions that are likely to be experienced in use of the main decking panels.

When openings 29 are punched in the web components of the main decking panels 3, small air breather holes are preferably also simultaneously punched in the tops of the web components to allow air to escape from underneath the top chord components when concrete is poured, thus ensuring that, with adequate vibration of the concrete, the void formed by the steel longitudinal stiffener of the main decking panel is effectively filled with concrete thus allowing a solid slab to be formed.

The top chord component may also be provided with openings (not shown).

The corrugated web components of the main decking panels 3 contribute as longitudinal steel in a composite slab, particularly when the steel stiffeners of these panels are filled with concrete and consequently the web components are sandwiched in the concrete making longitudinal slip very difficult.

The main and infill decking panels 3,5 can be made to any length.

Steel diaphragms 55 (Fig. 13) may be fitted near the ends of the main decking panels 3 to strengthen the web components against buckling due to large vertical reactions that occur in these locations.

These diaphragms 55 can also act as plugs to the ends of the channel members of the main decking panels preventing the ingress of concrete when this is required.

Either an internal or an external type of steel diaphragm can be fitted at locations where the main decking panels 3 extend over temporary or permanent supports, if it is necessary to strengthen the panels

against buckling of the webs due to the large vertical reaction.

Intermediate diaphragms or plugs can be fitted at a designated distance in from the ends of the main decking panels 3, and the openings in the web components can be punched out over this distance only. This can be done to enhance the vertical shear capacity of a composite slab in support regions. It can also be done to form solid concrete flanges of composite beams when composite slabs are shear connected to supporting steel or concrete beams.

For a similar purpose, the small open lap joint at the connection between a pair of main decking panels 3 and between a main decking panel 3 and an infill decking panel 5 can be locally squashed together or cut away to eliminate the void and therefore not interfere with the performance of any shear connectors placed near these joints if composite beams are formed with steel supporting beams without having a detrimental affect on the structural behavior of the main panels.

The infill panels 5 can be holed on site at any location to accommodate vertical building services. The width of the panels may be adjusted as necessary to suit the layout of the services. Purpose-built bridging elements can be used to support any main decking panels that are weakened by being cut to accommodate vertical building services or otherwise be temporarily supported from beneath.

The main decking panels 3 and infill decking panels 5 can be pre-assembled in a factory or on the ground at the building site into wider panels, with any transverse reinforcing bars required for a given design situation being fitted through openings in the web components of the main decking panels or being positioned

to sit on or be attached to the top chord components. These panels can then be lifted into final position, normally by crane. If the supports are not flat, and possibly even curved into an arch, then narrow main and infill decking panels, including the transverse reinforcement, will readily adjust to the shape of the supports.

Longitudinal reinforcing bars or post-tensioning cables can be supported in position so as to be cast in the lower regions of a composite slab between adjacent steel stiffeners of the main decking panels.

If voids formed by the channel members of the main decking panels are not filled with concrete, then if necessary, alternative materials can be used to improve thermal reflectivity and insulation, e.g. mineral fibre, under fire conditions, and/or sound insulation.

Typically, the main decking panels 3 and infill decking panels 5 are used to construct composite slabs. However, they can readily be used in different combinations and arrangements that suit the construction of non-composite and composite beam and slab arrangements, e.g. see Figs 15 and 16. In these types of applications, the openings in the web components are preferably removed on one side only of the main decking panels.

The use of galvanised decking materials can cause a high level of reflection and glare to the installers. This is an identified safety and occupational health and safety concern on site. The use of dull (non galvanised) materials in particular for the wide top chord component and web components of the main decking panel can greatly enhance safety and worker comfort.

The use of thin material in the pans of the base

component of the main and infill decking panels 3,5 results in transverse deflection between the channel members, with the greater this distance the more pronounced the deflection. The attachment of the web components of the main decking panels to the base component of the panels reduces the effective transverse span and hence deflection and hence minimises this as a design criterion for pan thickness. The void in the infill decking panels component can also act in a similar manner, reducing the transverse deflection and allowing the use of very thin materials.

Many modifications may be made to the preferred embodiments of the present invention described above without departing from the spirit and scope of the invention.